ATTACHMENT B

Amendments to the Specification

Please replace the paragraphs at page 13, line 15 to page 23, line 3 with the following amended paragraphs.

2. The engine according to paragraph 1. above can provide that the EGR bypass or conduit has a EGR valve making it possible to increase the turbine pressure above the compressor pressure.

3. The engine according to paragraph 1. above can provide that the turbocharging unit has an intake valve situated on the compressed air discharge conduit making it possible to increase the compressor pressure above the turbine pressure.

4. In an advantageous manner, the engine according to paragraph 1. can provide that the EGR conduit has a gas coolant at an adjustable temperature, preferably adjustable up to a temperature close to that of the fresh air.

5. This engine according to paragraph 2. above can provide that the adjustment of the temperature is effected by controlling a bypass of the coolant.

This general principle refers to Figure 1.

6. A method of supplying an engine according to paragraph 4. above can provide that the EGR temperature is controlled to create the desired excess of air for the combustion in the engine.

7. This method of supply according to paragraph 6. can in particular have the feature that the EGR temperature is controlled so that the mass of the recycled gases remains substantially equal to the mass of the fresh air up to the speed at which this

temperature returns to the exhaust temperature. Above this speed the recycled mass becomes greater than the mass of the fresh air.

8. This method of supply according to paragraph 6. can also have the feature that the EGR cooler is totally bypassed when the engine does not deliver propulsive power.

9. This method of supply according to paragraph 8. can in particular have the feature that for cold starting and operating at idling speed the adjustment of the turbine valves (6 and 7) and/or the timing of the engine valves is adjusted so that the excess of combustion air is minimal for the desired level of depollution.

These methods relate to different modes of controlling the bypass EGR according to whether it is required to ~~optimise~~optimize the smoke, the NOX, the noise or the pickup capacity of the engine.

10. The engine according to paragraphs 1. or 4. above can also have the feature that the adaptation speed Na is substantially equal to Nmin/2 so that the volume of recycled gases is at least equal to that of the fresh air, and the minimum temperature of the recycled gases is preferably close to the temperature of the fresh air so that the mass of the recycled gases is at least equal to that of the fresh air at the minimum speed used Nmin in order to depollute all the range of use of the engine.

11. The engine according to paragraph 1. can also have the feature that the turbocharging unit has a low-pressure LP turbocharger and a high-pressure HP compressor of which the compressors work in series with, preferably, a cooling of the air between the compressors and the exhaust section Sd can be adjusted between a minimum Sd min and a maximum Sd max by one or a combination of the following means:

adjustment of the variable section of the gas distributor of the turbines,
opening of a bypass between the inlet and the outlet of the turbines,

passage from a series configuration to a parallel configuration of the turbines.

The turbocharging adaptation speed Na thus becomes adjustable, in a continuous or discontinuous manner, between two values Na min and Na max.

In the following, a bypass between the inlet and the outlet of a turbine will be called a waste gate.

This structure refers to Figure 5.

12. The engine according to paragraph 11. above can again have the feature that the minimum exhaust section Sd min offered to the gases is formed by the two turbines mounted in series at maximum closure if their distributor is variable and all waste gates are closed if they exist.

These methods relate to all the modes chosen in order to describe the invention.

13. The engine according paragraph 12. can be arranged so that it operates on a 4-stroke cycle and the timing of the valves is fixed.

14. The engine according to paragraph 13. can also have the feature that the maximum exhaust section Sd max offered to the gases is formed by two turbines with fixed distributors mounted in parallel.

In order to pass the turbines from the series configuration to the parallel configuration of the means permitting the following manoeuvres to be carried out successively:

progressive partial opening of the HP waste gate

progressive and simultaneous partial opening of the HP and LP waste gates

simultaneously and rapidly: total opening of the HP waste gate, total closure of the LP waste gate, putting the outlet of the HP turbine into communication with the outlet of the LP turbine.

15. The engine according to paragraph 13. can also have the feature that the maximum exhaust section Sd max offered to the gases is formed by a LP turbine with fixed distributor and a HP turbine with variable distributor mounted in parallel, the HP distributor being fully open.

In order to pass the turbines from the series configuration to the parallel configuration of the means permitting the following manoeuvres to be carried out successively:

progressive opening of the distributor of the HP turbine

progressive partial opening of the LP waste gate

simultaneously and rapidly: total closing of the LP waste gate and putting the outlet of the HP turbine into communication with the outlet of the LP turbine.

These methods relate to the mode designated A4 hereafter.

16. A method of supplying an engine according to paragraphs 2., 3. or 11. above can also have the feature that in order to limit the frequency of changing the configuration the geometry is ~~immobilised~~immobilized for a type of driving which implements a limited power range, for example the series configuration for driving in town and the parallel configuration for driving on the open road, the power thresholds corresponding to each configuration can be crossed for manoeuvres of short duration, such as accelerating, overtaking, bursts of speed, etc.

The thresholds may be crossed as follows:

by closure of the EGR valve if the pressure in the exhaust manifold can be increased,

by opening of one or two waste gates if the exhaust temperature can be increased,

by closure of the intake valve if the maximum cycle pressure is reached or if the compressors are close to their maximum flow rate.

This method relates to the modes designated A1.1, A2, A3, B2, B4, C3, D3.

17. An engine according to paragraph 14. can also have the feature that the LP waste gate has a second seat in order simultaneously to effect the closure of the LP turbine inlet/outlet bypass and putting the HP turbine outlet into communication with the LP turbine outlet.

This method relates to the mode A4 below.

18. An engine according to paragraph 14. can also have the feature that the two waste gates are concentric and have stops in such a way that their simultaneous movements are actuated by one of them and communicated to the other by the said stops.

This structure refers to Figure 8.

19. The engine according to paragraph 13. above can have the feature that the maximum exhaust section Sd max is formed by two turbines with fully open variable distributors mounted in series, and the distributors are opened simultaneously in order to maintain the intake pressure at its maximum desired value on the full load curve.

This very expensive solution has not been taken as an example. Nevertheless, it may be substituted for all the modes presented.

20. An engine according to paragraph 12. above can also have the feature that the timing of the engine valves can be controlled so as to displace the closure of the cylinder between the vicinity of the BDC and the mid-stroke of the piston, the maximum exhaust section Sd is formed by the HP turbine in series configuration with the distributor fully open if it is variable, the HP waste gate fully open in the contrary case,

and the turbines are dimensioned so as to permit the compressors to reach their maximum pressure ratios simultaneously.

This relates to the modes B, C and D below.

21. A method of supplying an engine according to paragraph 20. above can have the feature that the full load curve as a function of the speed is as follows: from Nmin to 2 Nmin the intake closure Fa passes from the BDC (bottom dead centre) to approximately 90 degrees of the crankshaft after the BDC in such a way as to maintain the cycle pressure below its desired value. The distributor or the HP waste gate is closed, from 2 Nmin to approximately 3 Nmin the HP distributor or the HP waste gate is open and possibly the LP waste gate in order to maintain the intake pressure at its maximum desired value, FA (intake closing) is maintained at 90 degrees of the crankshaft after the BDC, from 3 Nmin to Nmax the global flow rate of fuel is kept constant in order to maintain the intake pressure at its limiting value, at partial load the timing of FA will be controlled according to a map ~~memorised~~memorized by the engine control computer.

This method described by Figure 2 relates to the modes B1, C2, D2 below.

22. An engine according to paragraph 12. above can have the feature that it operates on the 2-stroke cycle, the intake ports are closed by valves, the exhaust ports are closed by valves and communicate with one single exhaust manifold, the external recycling phase precedes the scavenging, the timing of the valves can be controlled so as to displace the closure of the cylinder between the vicinity of the BDC and the mid-stroke of the piston, the maximum exhaust section Sd is formed by the HP turbine in series configuration with the distributor fully open if it is variable, the HP waste gate fully open in the contrary case, the turbines are dimensioned so as to permit the compressors to reach their maximum pressure ratios simultaneously, the EGR valve is replaced by a check valve or a closable aerodynamic diode.

23. A method of supplying an engine according to paragraph 22. above can have the feature that the full load curve as a function of the speed is as follows:

from Nmin to 2 Nmin the closure of the cylinder passes from the BDC to approximately 90 degrees of the crankshaft after the BDC in such a way as to maintain the cycle pressure at its desired value,

the distributor or the HP waste gate is closed,

from 2 Nmin to approximately 3 Nmin the HP distributor or the HP waste gate is open and possibly the LP waste gate in order to maintain the intake pressure at its maximum desired value, FA (intake closing) is maintained at 90 degrees of the crankshaft after the BDC,

from 3 Nmin to Nmax the global flow rate of fuel is kept constant in order to maintain the intake pressure at its limiting value.

In order to ~~maximise~~maximize the cooled external EGR, the depolluted partial loads can be effected as follows:

the cylinder remains closed in the vicinity of the BDC and the turbines remain in closed configuration up to the P2 limit for this timing,

the turbines are then opened in order to maintain P2 at its limiting value,

the aerodynamic diode when the external recycling flow stops.

This method refers to Figure 6 and relates to the modes C below.

24. An engine according to paragraph 12. above can have the feature that:

it operates on the 2-stroke cycle,

it has two exhaust ports per cylinder, closed by valves, which communicate respectively with an exhaust manifold connected to the turbine and an exhaust manifold connected to the EGR conduit and/or to the turbine via a controlled distributor valve,

the timing of the valve assigned to the EGR can be controlled so as to displace the closure of the cylinder between the vicinity of the BDC and the mid-stroke of the piston,

the external recycling phase precedes the scavenging when the cylinder closes in the vicinity of the BDC and follows it when the cylinder closes at the mid-stroke of the piston,

the maximum exhaust section Sd is formed by the HP turbine in series configuration with the distributor fully open if it is variable, the HP waste gate fully open in the contrary case,

the turbines are dimensioned so as to permit the compressors to reach their maximum pressure ratios simultaneously,

the EGR valve is replaced by a check valve or a closable aerodynamic diode.

25. The method of supplying an engine according to paragraph 24. above can have the feature that the pressure P2 is lower than the limit allowed for this timing, the distributor valve is in the recycling position, the cylinder is closed in the vicinity of the BDC, the distributor or the HP waste gate are closed, the pressure reaches the limiting value allowed for this timing, the closure of the cylinder is displaced to the mid-stroke of the piston in order substantially to double the allowed P2 limit, the distributor valve remains in the recycling position, the distributor or the HP waste gate remain closed, the pressure P2 reaches the new limit allowed for this new timing, the distributor valve blocks the recycling, the distributor or the HP waste gate open in order to keep the P2 at its new allowed limit, the transition can be made progressively in the two directions or rapidly with a hysteresis.

This method refers to Figure 7 and relates to the modes D below.

26. The method according to one of the preceding modes can also have the feature that at full load the variable geometry is controlled so as to maintain a parameter at its limiting desired value, at partial load the variable geometry is controlled so as to ~~optimise~~optimize the depollution and/or the performance according to a map ~~memorised~~memorized in the engine control computer.

27. An engine according to paragraph 1. above, including a flat cylinder head bearing valves of which the faces on the chamber side are coplanar with the cylinder head and substantially tangent to the cylinder, can be such that the intake pipe or pipes terminate(s) by an oblong nozzle defined by an upper half-cylinder resting on the upper edge of the conical seat and tangent to this latter along its generating line situated in a plane substantially perpendicular to the plane passing through the axis of the seat and through the axis of the cylinder and through a lower cylinder covering half of the valve head opposite the said generating line.

The nozzles are also oriented so as to create a tangential air velocity in the same direction.

The angles of the seats are chosen so as to ~~optimise~~optimize the stratification of the combustive charge.

28. An engine according to paragraph 1. above, including a flat cylinder head bearing valves of which the faces on the chamber side are coplanar with the cylinder head and substantially tangent to the cylinder, can be such that the conical sealing bearing surface of the intake valves is extended towards the piston by a cylindrical part of a height slightly greater than the lift of the said valves, that the conical seats of the said valves are disposed at the bottom of cylindrical recesses provided in the cylinder head in order to receive the said cylindrical parts of the said valves in such a way that the flat lower faces of the valves are in the plane of the cylinder head when they rest on their seats, the clearance between the recesses and the valves being minimal,
that recesses are provided in the cylinder head which do not go beyond the following boundaries:

two cylindrical portions concentric with the bore and tangent externally and internally to the cylindrical recess of each valve,

a conical surface extending the half-seat of the valve delimited by a plane passing through the axis thereof and the axis of the cylinder,

the recesses will also be oriented so as to create a tangential velocity in the same direction,

the angle of the seats is chosen so as to ~~optimise~~optimize the stratification of the combustive charge.

29. An engine according to paragraphs 27. or 28. above can have the feature that it includes two diametrically opposed intake valves.

These structures described in Figure 11 relate to modes in which the residual exhaust gases are retained in the cylinder.

30. An engine according to paragraph 1. can have the feature that a fraction of the recycled gases is retained in the cylinder at the closure of the latter, the fresh gases are introduced by directive intake conduits with the aim of ~~organising~~organizing a stratification of the temperatures and the concentrations in the chamber at the combustion top dead center, the fuel is ~~vaporised~~vaporized in the fresh gases.

An advantageous solution for a radial stratification provides confining the combustion in a central bowl of small diameter which fills with the hot gases concentrated at the center of the cylinder during the compression whilst the carburetted mixture of fresh air is centrifuged in the peripheral space between the piston and the cylinder head until the start of its transfer into the bowl. If the richness of the carburetted mixture is situated between 60 and 70%, the flame initiated on contact of the hot gases present in the bowl will not propagate towards the peripheral fresh gases but will develop by turbulent mixing with the hot gases already present in the bowl. The excess of air present in all points of the chamber guarantees complete combustion without NOX or particles. The layer of carburetted air remaining in the clearance between the piston and the cylinder head which does not take part in the combustion in the bowl will be burned at the start of expansion or at the following cycle. The recirculated gases serve in this case to initiate and to maintain the combustion of a poor mixture during its turbulent transfer into the combustion bowl. The initial ignition can be ensured by an electric spark.

31. Such an engine according to paragraph 30. can also have the feature that the fuel is introduced into the pure air between the compressor and the external EGR mixer.

32. An engine according to paragraph 30. can also have the feature that the fuel is introduced into the mixture between the pure air and the external EGR.

33. An engine according to paragraph 30. can also have the feature that the ignition point is controlled by the timing of the valves at the closure of the cylinder.

34. An engine according to paragraph 30. can also have the feature that the ignition point is controlled by the temperature of the external EGR.

35. An engine according to paragraph 30. can also have the feature that the first ignition is controlled electrically or is triggered spontaneously by the injection of the fuel at high pressure at the top dead centre.

36. An engine according to paragraph 30. can also have the feature that the working chamber of the gases has a geometry revolving around the axis of the cylinder, the stratification has a geometry revolving around the axis of the cylinder and created by the orientation of the intake ports, the temperature of the combustive charge increases between the periphery and the axis so that the self-ignition is propagated from the centre towards the periphery.

37. An engine according to paragraph 36. can also have the feature that the meridian profile of the combustion chamber is chosen so as to ~~optimise~~optimize the rate of heat release by the progressiveness of the isothermal surfaces of the reactive load.

Please replace the paragraph at page 29, line 22 to page 24, line 2 with the following amended paragraph.

- A conduit for recirculation of the exhaust gases connecting the exhaust manifold to the intake manifold through a gas cooler 109. This conduit is equipped with a controlled EGR valve ~~105~~ 104 at its junction with the exhaust manifold and with a cooler bypass regulated by a controlled distributor flap 106. The combustive mixture is ~~homogenised~~homogenized by the mixer 110 situated upstream or in the intake manifold.

Please replace the paragraph at page 53, lines 4-6 with the following amended paragraph.

The combustive mixture is produced in the cylinder during filling with a possibility of stratification described in US Patent No. 5,5~~5~~17,954, which is hereby incorporated by reference.